

# **ADINA User Interface Primer**

Report ARD 09-6

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ADINA R&D, Inc.  
71 Elton Avenue  
Watertown, MA 02472 USA

tel. (617) 926-5199  
telefax (617) 926-0238  
[www.adina.com](http://www.adina.com)

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# **Introduction**

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## Objective

The AUI primer is designed to familiarize you with the basic functionality and usage of the ADINA System version 8.6, in particular the basic functionality and usage of the AUI (ADINA User Interface).

The problems solved in the primer are designed to illustrate different features of the AUI. The problems are presented in enough detail so that you can work through them without additional assistance. The problems are briefly summarized here:

*Problem 1: Deflection of a beam.* We introduce the geometry-based modeling features of the AUI with a simple beam problem. Several variants of the same problem are presented to demonstrate how an existing model can be modified.

*Problem 2: Plate with a hole in tension.* We generate elements onto several geometry surfaces. Deletion and regeneration of elements is demonstrated. Zooming into the graphics window and graph plotting are introduced.

*Problem 3: Plate with a hole in tension using ADINA-M.* Problem 2 is solved using the “body sheet” feature of ADINA-M. The advantage of using the body sheet feature is that the geometry does not need to be broken up into several geometry surfaces. We also demonstrate how to transform the stresses into a cylindrical coordinate system.

*Problem 4: Cylinder subjected to tip load.* We generate elements onto a geometry volume. During the problem solution we rotate the mesh plot with the mouse.

*Problem 5: Round bar with circumferential groove subjected to tip loading.* We generate 3-D elements by revolving 2-D elements about an axis.

*Problem 6: Square wall-driven cavity.* We introduce two-dimensional fluid flow modeling with the AUI and ADINA-CFD.

*Problem 7: Contact between a block and a rigid cylinder.* We demonstrate modeling of contact conditions. We also show the use of time functions to control load levels in static analysis. In addition we show how to create an animation file in different graphics formats.

*Problem 8: Analysis of a shell corner.* We demonstrate modeling of a simple shell structure. We also demonstrate frequency analysis.

*Problem 9: Thermal stress analysis of a cylinder.* We demonstrate thermal analysis with ADINA-Thermal, then we show how the temperature solution is included in stress analysis.

*Problem 10: Beam subjected to impact load.* We demonstrate setting up a dynamic analysis. We also show how to perform a restart analysis.

## *Introduction*

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*Problem 11: Beam subjected to impact load —mode superposition.* Problem 10 is solved using mode superposition for the dynamic time integration.

*Problem 12: Beam subjected to earthquake load.* We demonstrate setting up a response spectrum analysis.

*Problem 13: Visualizing the mesh quality.* The plate with a hole considered in problem 2 is reanalyzed using the relatively inefficient 3 and 4-node elements. Our purpose is to demonstrate the mesh quality indicators of the AUI.

*Problem 14: Pushover analysis of a frame.* We demonstrate the use of the moment-curvature material model in modeling a simple structure. We also show the use of the ATS method to determine a collapse load.

*Problem 15: Acoustic analysis of a monopole.* We demonstrate the ADINA potential-based fluid elements and the ADINA-CFD fluid elements in an FSI (fluid-structure-interaction) analysis.

*Problem 16: Analysis of a shaft-shaft intersection with ADINA-M:* We demonstrate the usage of ADINA-M for the definition of a simple solid geometry, then we mesh the solid geometry with free-form meshing and obtain a linear static solution.

*Problem 17: Analysis of a cracked body with ADINA-M:* We demonstrate the modeling of a cracked body in which the cracked region is modeled with native AUI geometry and meshed with a mapped mesh and the remainder of the body is modeled with ADINA-M and meshed with a free-form mesh. We also demonstrate fracture mechanics analysis (3-D stationary crack).

*Problem 18: Fluid flow over a flexible structure in a channel.* We demonstrate FSI analysis in which the deformation of a flexible structure affects the flow field. A moving mesh is used in the fluid domain.

*Problem 19: Fluid flow and mass transfer within a pipe.* We demonstrate 3D fluid flow analysis with mass transfer.

*Problem 20: Natural convection and specular radiation within an enclosure.* We demonstrate 2D fluid flow analysis in which natural convection and specular radiation are considered. We also demonstrate the automatic nondimensionalization feature and free-form meshing within geometry surfaces.

*Problem 21: Conjugate heat transfer and natural convection within an enclosure.* We demonstrate 2D fluid flow analysis in which “solid” element groups are used to model walls and in which the walls are subjected to radiation and convection boundary conditions.

*Problem 22: Rubber O-ring pressed between two frictionless plates.* We demonstrate the modeling of a simple rubber component. The ATS method is used to obtain the solution in one load step.

*Problem 23: Limit load analysis of a pipe bend.* We demonstrate limit load analysis of a pipe bend modeled with shell elements and an elastic-plastic material description.

*Problem 24: Deformation of a pipe due to internal fluid flow.* We demonstrate 3-D FSI analysis with a pipe flow problem. The pipe is modeled with shell elements and the fluid is modeled with 6-node prismatic fluid elements. We use slip boundary conditions between the fluid and the solid to minimize the number of fluid elements required.

*Problem 25: Heat transfer from solidifying concrete blocks.* We demonstrate how to add elements to a model using the element birth/death feature, and we discuss the modeling of a convection boundary condition that changes during the analysis. This problem is solved using ADINA-Thermal.

*Problem 26: Analysis of a cable-stayed bridge.* We demonstrate how to read in batch file commands into the AUI, and show some analyses useful in bridge analysis: dead load analysis, response spectrum analysis, dynamic analysis with prescribed ground motion.

*Problem 27: Beam subjected to harmonic and random loads.* We demonstrate how to perform harmonic and random vibration analysis on a simple beam structure.

*Problem 28: Unsteady fluid flow over a flexible structure in a channel.* We demonstrate particle tracing in an unsteady flow field.

*Problem 29: Analysis of a shell-shell intersection with ADINA-M.* We demonstrate the use of ADINA-M in modeling shell-shell intersections. We also demonstrate how to plot bending moments and membrane forces within shells.

*Problem 30: Analysis of fluid-structure interaction within a pipe constriction.* We demonstrate some of the features of the subsonic potential-based fluid elements of ADINA: prescribed mass fluxes, infinite boundary conditions, steady-state and dynamic analysis. We also demonstrate the axisymmetric shell element.

*Problem 31: Analysis of a laminar step-wall diffuser.* We demonstrate the input of a parabolic velocity boundary condition.

*Problem 32: Analysis of a broken dam using the VOF method.* We demonstrate the VOF (volume of fluid) method.

*Problem 33: U-bending of a metal sheet – static-implicit and dynamic-explicit analysis.* We demonstrate various features used in metal forming analysis, including the rigid-target contact algorithm. We also demonstrate explicit time integration.

## *Introduction*

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*Problem 34: Thermo-mechanical-coupling analysis of a disc braking system.* We demonstrate ADINA-TMC in the solution of a fully-coupled thermo-mechanical analysis. We also demonstrate the contact-slip loads.

*Problem 35: Viscoelastic foam O-ring pressed between two frictionless plates.* We demonstrate modeling of an “auxetic” foam material with temperature-dependent viscoelastic effects.

*Problem 36: Analysis of a rising air bubble using the VOF method.* We demonstrate the use of the VOF method in the analysis of air bubbles.

*Problem 37: FSI analysis of a simplified turbine using a sliding mesh.* We demonstrate the sliding-mesh feature of ADINA-CFD.

*Problem 38: Analysis of a steam-air heat exchanger.* We demonstrate the use of ASME steam table materials, fan boundary conditions, and the multigrid solver of ADINA-CFD.

*Problem 39: Thermal FSI analysis of a heated hemispherical dome.* We demonstrate thermal FSI modeling, and the use of a layer table to control the meshing near boundaries.

*Problem 40: Analysis of a cracked body with ADINA-M — gluemesh.* We solve the same problem as primer problem 17, this time using the gluemesh feature to connect the mapped and free mesh regions.

*Problem 41: Analysis of a screwdriver with ADINA-M.* We demonstrate importing of a Parasolid file into ADINA-M, then we demonstrate modifying the geometry using the discrete boundary representation (discrete BREP) feature.

*Problem 42: 3D turbulent flow in a strongly curved channel.* We demonstrate the FCBI-C elements of ADINA-CFD and the k- $\epsilon$  turbulence model.

*Problem 43: Contact between a block and a rigid cylinder, TLA-S method.* We demonstrate the use of the TLA-S method to obtain the final deformed solution of a large strain contact problem, without the need to specify solution steps or time functions.

*Problem 44: Analysis of a bracket assembly with a bolt.* We demonstrate the use of the bolt element.

*Problem 45: Large displacement bending of a plate by an applied moment.* We demonstrate some consequences of using 6 degree of freedom nodes in large displacement shell analysis.

*Problem 46: Thermal stress analysis of a cylinder – ADINA TMC model.* We solve the thermal stress problem of Problem 9 using the ADINA TMC feature of ADINA Structures.

*Problem 47: Numerical experiments with rubber material models.* We perform simple numerical experiments to demonstrate the ability of rubber material models to fit experimental data, and to demonstrate the stability of rubber material models in biaxial tension. The rubber material models considered are Mooney-Rivlin, Ogden and Sussman-Bathe.

*Problem 48: Flow between cylinders using adaptive CFD.* We demonstrate the use of the adaptive CFD feature to refine a fluid mesh where needed, in the steady-state analysis of laminar flow between cylinders.

*Problem 49: Analysis of a parachute using adaptive CFD.* We demonstrate the use of the adaptive CFD feature to remesh a moving fluid mesh when the mesh becomes too distorted, in an FSI problem of a parachute immersed in air.

If you are interested in learning about a specific topic, the Topic Indexes chapter can help you find the problem(s) in which the topic is discussed.

## **Revisions in this printing**

This printing of the AUI Primer has some revisions compared with the previous printing (report ARD 08-6, February 2008).

### *New problems in this printing:*

Problems 48 and 49 are new.

### *Revised problems in this printing:*

Problems 17 and 40: A different mapped mesh layout is used to allow fracture mechanics. Fracture mechanics instructions are added.

Problem 22: The rubber material constants are changed, to be more realistic.

Problem 42: The turbulence material model is changed from SST to k- $\epsilon$ .

Problem 44: The new bolt element feature is used.

## **Additional documentation**

At the time of printing of this manual, the following documents are available with the ADINA System:

### **Installation Notes**

Describes the installation of the ADINA System on your computer.

**ADINA User Interface Command Reference Manual**

**Volume I: ADINA Solids & Structures Model Definition, Report ARD 09-2, May 2009**

**Volume II: ADINA Heat Transfer Model Definition, Report ARD 09-3, May 2009**

**Volume III: ADINA CFD & FSI Model Definition, Report ARD 09-4, May 2009**

**Volume IV: Display Processing, Report ARD 09-5, May 2009**

These documents describe the AUI command language. You use the AUI command language to write batch files for the AUI.

**ADINA User Interface Primer, Report ARD 09-6, May 2009**

This manual.

**Theory and Modeling Guide**

**Volume I: ADINA Solids & Structures, Report ARD 09-7, May 2009**

**Volume II: ADINA Heat Transfer, Report ARD 09-8, May 2009**

**Volume III: ADINA CFD & FSI, Report ARD 09-9, May 2009**

Provides a concise summary and guide for the theoretical basis of the analysis programs ADINA, ADINA-Thermal, ADINA-CFD, ADINA-FSI and ADINA-TMC. The manuals also provide references to other publications that contain further information, but the detail contained in the manuals is usually sufficient for effective understanding and use of the programs.

**ADINA Verification Manual, Report ARD 09-10, May 2009**

Presents solutions to problems that verify and demonstrate the usage of the ADINA System. Input files for these problems are distributed along with the ADINA System programs.

**TRANSOR for I-deas Users Guide, Report ARD 09-15, May 2009**

Describes the interface between the ADINA System and I-deas.

**ADINA System 8.6 Release Notes, May 2009**

Provides a description of the new and modified features of ADINA System 8.6.

You will also find the following book useful:

**K.J. Bathe, *Finite Element Procedures*, Prentice Hall, Englewood Cliffs, NJ, 1996**

Provides theoretical background to many of the solution techniques used in the ADINA System.

# **Icon locator tables**













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Use the following tables to find out where icons are located.

Icons are organized into six toolbars: General, Display, Modeling, ADINA-M (UNIX only), Results, Macro. In addition, some icons can be found on the Module Bar. Choose View→Toolbars to display or hide the toolbars.

This table refers to the standard locations of the icons (that is, to the locations of the icons before any user customizations).


















### Icons from Active Zone to Boolean Operator

Icon name and picture	Location
Active Zone 	Display toolbar <sup>1</sup>
All Mesh Lines 	Results toolbar <sup>2</sup>
Analysis Options 	Module bar
Animate 	Results toolbar
Apply Fixity 	Modeling toolbar
Apply Load 	Modeling toolbar
Batch Continue 	General toolbar
Bitmap Snapshot 	General toolbar
Body Modifier 	ADINA-M toolbar
Body Revolved 	ADINA-M toolbar
Body Sweep 	ADINA-M toolbar
Boolean Operator 	ADINA-M toolbar

Notes:

- 1) This icon is in the Zone drop-down list.
- 2) This icon is in the Lines drop-down list.

**Icons from Boundary Plot to Define Contact Pairs**
















<b>Icon name and picture</b>	<b>Location</b>
Boundary Plot 	General toolbar
Change Zone 	Display toolbar <sup>1</sup>
Clear 	General toolbar
Clear Band Plot 	Results toolbar
Clear Trace Plot 	Results toolbar
Clear Vector Plot 	Results toolbar
Color Element Groups 	Display toolbar
Create Band Plot 	Results toolbar
Create Vector Plot 	Results toolbar
Coordinate Systems 	Modeling toolbar
Cross Sections 	Modeling toolbar
Cull Front Faces 	Display toolbar
Cut Surface 	Results toolbar
Data File/Solution 	Modeling toolbar
Define Bodies 	Modeling toolbar, ADINA-M toolbar
Define Contact Groups 	Modeling toolbar
Define Contact Pairs 	Modeling toolbar <sup>2</sup>

Notes:

1) This icon is in the Zone drop-down list.

2) This icon is in the Define Contact Groups drop-down list.

### Icons from Define Contact Surfaces to Display Zone












Icon name and picture	Location
Define Contact Surfaces 	Modeling toolbar <sup>1</sup>
Define Element Groups 	Modeling toolbar
Define Lines 	Modeling toolbar
Define Points 	Modeling toolbar
Define Section Sheet 	ADINA-M toolbar
Define Surfaces 	Modeling toolbar
Define Volumes 	Modeling toolbar
Define Zone 	Display toolbar <sup>2</sup>
Delete Bodies 	Modeling toolbar
Delete Lines 	Modeling toolbar
Delete Mesh 	Modeling toolbar
Delete Points 	Modeling toolbar
Delete Surfaces 	Modeling toolbar
Delete Volumes 	Modeling toolbar
Display Zone 	Display toolbar <sup>2</sup>

Notes:

1) This icon is in the Define Contact Groups drop-down list.

2) This icon is in the Zone drop-down list.

### Icons from Dynamic Pan to Group Outline

Icon name and picture		Location
Dynamic Pan <sup>1</sup>		General toolbar
Dynamic Resize <sup>2</sup>		General toolbar
Dynamic Rotate (XY) <sup>3</sup>		General toolbar
Dynamic Rotate (Z) <sup>4</sup>		General toolbar
Element Labels		Display toolbar
Error Plots		Results toolbar
Fast Forward		Results toolbar
Fast Rewind		Results toolbar
First Solution		Results toolbar
FSI Options		Module bar
Group Outline		Results toolbar <sup>5</sup>

Notes:

1) Dragging the mouse moves all picked graphics. You can also hold down the Ctrl key to resize all picked graphics, the Shift key to rotate graphics out-of-plane or the Alt key to rotate graphics in-plane.



















2) Dragging the mouse resizes all picked graphics (equivalent to holding down the Ctrl key when the Dynamic Pan icon is pressed).

3) Dragging the mouse rotates all picked graphics out-of-plane (equivalent to holding down the Shift key when the Dynamic Pan icon is pressed).

4) Dragging the mouse rotates all picked graphics in-plane (equivalent to holding down the Alt key when the Dynamic Pan icon is pressed).

5) This icon is in the Lines drop-down list.


















### Icons from Hidden Surfaces Removed to Mesh Point

Icon name and picture	Location
Hidden Surfaces Removed 	Display toolbar
Highlight 	General toolbar
Import Parasolid Model 	ADINA-M toolbar
Iso View 1 	Display toolbar <sup>1</sup>
Iso View 2 	Display toolbar <sup>1</sup>
Iso View 3 	Display toolbar <sup>1</sup>
Last Solution 	Results toolbar
Line/Edge Labels 	Display toolbar
Load Plot 	General toolbar
Manage Materials 	Modeling toolbar
Measure 	General toolbar
Measure Angle 	General toolbar
Mesh Bodies 	ADINA-M toolbar
Mesh Edges 	ADINA-M toolbar
Mesh Faces 	ADINA-M toolbar
Mesh Lines 	Modeling toolbar
Mesh Plot 	General toolbar
Mesh Point 	Modeling toolbar

Notes:

1) This icon is in the View drop-down list.

**Icons from Mesh Rigid Contact Surface to Pick**





















<b>Icon name and picture</b>	<b>Location</b>
Mesh Rigid Contact Surface 	Modeling toolbar <sup>1</sup>
Mesh Surfaces 	Modeling toolbar
Mesh Volumes 	Modeling toolbar
Mesh Zoom 	General toolbar
Model Outline 	Results toolbar <sup>2</sup>
Modify Band Plot 	Results toolbar
Modify Mesh Plot 	General toolbar
Modify Vector Plot 	Results toolbar
Movie Load Step 	Results toolbar
Movie Mode Shape 	Results toolbar
Next Solution 	Results toolbar
New 	General toolbar
No Mesh Lines 	Results toolbar <sup>2</sup>
Node Labels 	Display toolbar
Node Symbols 	Display toolbar
Open 	General toolbar
Pick 	General toolbar

Notes:



















1) This icon is in the Define Contact Groups drop-down list.

2) This icon is in the Lines drop-down list.

### Icons from Point Labels to Show Discrete BREP

Icon name and picture	Location
Point Labels 	Display toolbar
Previous Solution 	Results toolbar
Query 	General toolbar
Quick Band Plot 	Results toolbar
Quick Vector Plot 	Results toolbar
Redo 	General toolbar
Redraw 	General toolbar
Refit 	General toolbar
Refresh 	General toolbar
Reset Mesh Plot Style 	Display toolbar
Reset View 	Display toolbar
Save 	General toolbar
Save AVI 	Results toolbar (Windows version only)
Save Mesh Plot Style 	Display toolbar
Save View 	Display toolbar
Scale Displacements 	Results toolbar
Shading 	Display toolbar
Show Contact Surfaces 	Display toolbar
Show Deformed Mesh 	Results toolbar
Show Discrete BREP 	ADINA-M toolbar















**Icons from Show Geometry to Surface/Face Labels**

<b>Icon name and picture</b>	<b>Location</b>
Show Geometry 	Display toolbar
Show Lines/Edges 	Display toolbar
Show Material Axes 	Display toolbar
Show Original Mesh 	Results toolbar
Show Points 	Display toolbar
Show Rigid Links and Constraints 	Display toolbar
Show Segment Normals 	Display toolbar
Show Surfaces/Faces 	Display toolbar
Skew System Plot 	Display toolbar
Smooth Plots 	Results toolbar
Special Boundary Conditions 	Modeling toolbar
Subdivide Bodies 	Modeling toolbar <sup>1</sup>
Subdivide Edges 	Modeling toolbar <sup>1</sup>
Subdivide Faces 	Modeling toolbar <sup>1</sup>
Subdivide Lines 	Modeling toolbar <sup>1</sup>
Subdivide Surfaces 	Modeling toolbar <sup>1</sup>
Subdivide Volumes 	Modeling toolbar <sup>1</sup>
Surface/Face Labels 	Display toolbar

Notes:

1) This icon is in the Define Element Groups drop-down list.

### Icons from Trace Downstream to Zoom

Icon name and picture	Location
Trace Downstream 	Results toolbar
Trace Upstream 	Results toolbar
Undo 	General toolbar
Unhighlight 	General toolbar
Unzoom All 	General toolbar
Unzoom Partially 	General toolbar
Vector Snapshot 	General toolbar
Volume/Body Labels 	Display toolbar
Wire Frame 	Display toolbar
XY View 	Display toolbar <sup>1</sup>
XZ View 	Display toolbar <sup>1</sup>
YZ View 	Display toolbar <sup>1</sup>
Zone Colors 	Display toolbar <sup>2</sup>
Zoom 	General toolbar

Notes:

1) This icon is in the View drop-down list.

2) This icon is in the Zone drop-down list.

*Icon locator tables*

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# Hints

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**Program versions:** ADINA System program versions are divided into two categories: UNIX and Windows. UNIX versions of the ADINA System include the HP-UX PA-RISC version, the HP-UX Itanium version, the IBM AIX version, the Linux x86 version, the Linux x86\_64 version, the Linux Itanium version and the Sun OS version. The Windows version of the ADINA System is the version used on PCs running Microsoft Windows (2000, XP).

The UNIX and Windows versions of the AUI are somewhat different. Therefore the Primer instructions occasionally are different for the UNIX and Windows versions.

**Invoking the AUI:** Here are detailed instructions for invoking the AUI:

*UNIX:* At the UNIX command prompt, type

```
au18.6
```

*Windows:* From the Start Menu, choose Programs→ADINA System 8.6→ADINA-AUI.

Choose ADINA Structures, ADINA Thermal or ADINA CFD from the Module drop-down list (the drop-down list near the top left of the AUI control window) to prepare for pre-processing an ADINA, ADINA-Thermal or ADINA-CFD model.

**Icon toolbars:** In the primer instructions, we assume that all of the icon toolbars are selected and that all of the icons are displayed in the toolbars. Use the View menu to make sure that all of the toolbars are selected.

**Filling in a table:** If we ask you to fill in a table, you may find it easier to enter the table column-by-column rather than row-by-row. In other words, first fill in column 1, then column 2, etc. instead of filling in row 1, then row 2, etc.

**Names in dialog boxes:** When we ask you to enter a name or other text in the dialog boxes, we write it in upper-case. But you can type the name or text in either upper-case, lower-case or a mixture of upper and lower-case letters. For example, the following instructions come from problem 15:

Choose Definitions→Variable→Resultant, add Resultant name R, define it as

```
SQRT(<Y-COORDINATE>**2 + <Z-COORDINATE>**2)
```

You can type the name R as either an upper-case R or a lower-case r, and you can type the resultant itself using upper-case, lower-case or a mixture of upper and lower-case letters.

**Choosing variables:** When we ask you to choose a variable, we use instructions such as

```
Set Variable 1 to (Displacement:Y-DISPLACEMENT)
```


## Hints

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What this means is that you should choose Displacement from the left-hand list for the field, then choose Y-DISPLACEMENT from the right-hand list for the field.


**DISP MAG number:** Many plots from the post-processor display the text DISP MAG ... . DISP MAG is an abbreviation for displacement magnification factor. The DISP MAG number is affected by many factors, including the size and aspect ratio of the graphics window. Therefore the DISP MAG numbers of your plots will be slightly different than the DISP MAG number of our plots.



### Quick review of graphics operations

*Picking graphics:* Click the Pick icon , then click on one of the lines of the graphics to be picked (for example, a mesh plot). A bounding box appears around the graphics; this bounding box indicates the graphics is highlighted. To unhighlight the graphics, move the cursor onto empty space within the graphics window and click the left mouse button.

You can also create a rubber-band box (marquee box) with the Pick icon. Click on empty space, then move the cursor while holding down the left mouse button. When the box is the correct size, release the left mouse button.


*Moving graphics:* First pick the graphics. Click the Dynamic Pan icon , hold down the left mouse button and move the cursor. The picked graphics moves along with the mouse cursor. When the picked graphics is in the proper position, release the left mouse button.



*Resizing graphics:* First pick the graphics. Click the Dynamic Resize icon , hold down the left mouse button and move the mouse diagonally up and to the right to enlarge the picked graphics and move the mouse diagonally down and to the left to shrink the picked graphics. The picked graphics dynamically resizes as you move the mouse. When the picked graphics is the proper size, release the left mouse button.


Hint, instead of clicking the Dynamic Resize icon , click the Dynamic Pan icon  and hold the Ctrl key while dragging the mouse.



Using the above instructions, the graphics are resized around their center. If you have zoomed into the model before resizing, you might find it more convenient to resize the graphics around the center of the graphics window. To do this, hold down both the Ctrl and Shift keys together while dragging the mouse.


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*Rotating graphics out-of-plane:* First pick the graphics. Click the Dynamic Rotate (XY) icon , hold down the left mouse button and move the mouse. The picked graphics dynamically rotates as you move the mouse. When the picked graphics is in the proper orientation, release the left mouse button.

Hint, instead of clicking the Dynamic Rotate (XY) icon , click the Dynamic Pan icon  and hold the Shift key while dragging the mouse.

*Rotating graphics in-plane:* First pick the graphics. Click the Dynamic Rotate (Z) icon , hold down the left mouse button and move the mouse. The picked graphics dynamically rotates as you move the mouse. When the picked graphics is in the proper orientation, release the left mouse button.

Hint, instead of clicking the Dynamic Rotate (Z) icon , click the Dynamic Pan icon  and hold the Alt key while dragging the mouse. This hint will not work on those UNIX computers in which the Alt key is reserved for window manager operations.

*Erasing graphics:* First pick the graphics. Then click the Erase icon  or press the Del key.

*Resizing element vectors:* First pick an element vector. The AUI draws a diamond around the element vector. Follow the instructions above for “resizing graphics” to resize the element vectors. You can also press the – key to remove element vectors, the + key to add element vectors (up to all element vectors) or the Enter key to display all element vectors.

*Filling in a dialog box field with a P button:* Use the mouse to fill in a dialog box field with a P button, for example, a dialog box field that requires a node number. Click the P button. The dialog box disappears and the cursor changes to a cross. Click on the desired graphics (the node, for example). The node becomes highlighted and the dialog box reappears with the number of the selected node in the dialog box field.

Some dialog boxes have one P button for several dialog box fields. In that case, the dialog box reappears when you have made one selection for each field.

If you need to cancel filling in the dialog box field, press the Esc key.

*Filling in a column of a dialog box table:* Use the mouse to fill in a green column of a table, for example, a column that requires node numbers. Double-click in the green column. The dialog box disappears and the cursor changes to a cross. Click on the desired graphics (the node, in this example). The node becomes highlighted. Each selection that you make fills in another cell in the column. To return to the dialog box, press the Esc key.

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# **Topic indexes**

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For each topic, we give the problem number(s) in which the topic is introduced or discussed in some detail. If the topic is used without discussion in a problem, the problem number is not given.

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